

# Populating 25G-EPON PR30 PMD Tables

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# Supporters

100G-EPON



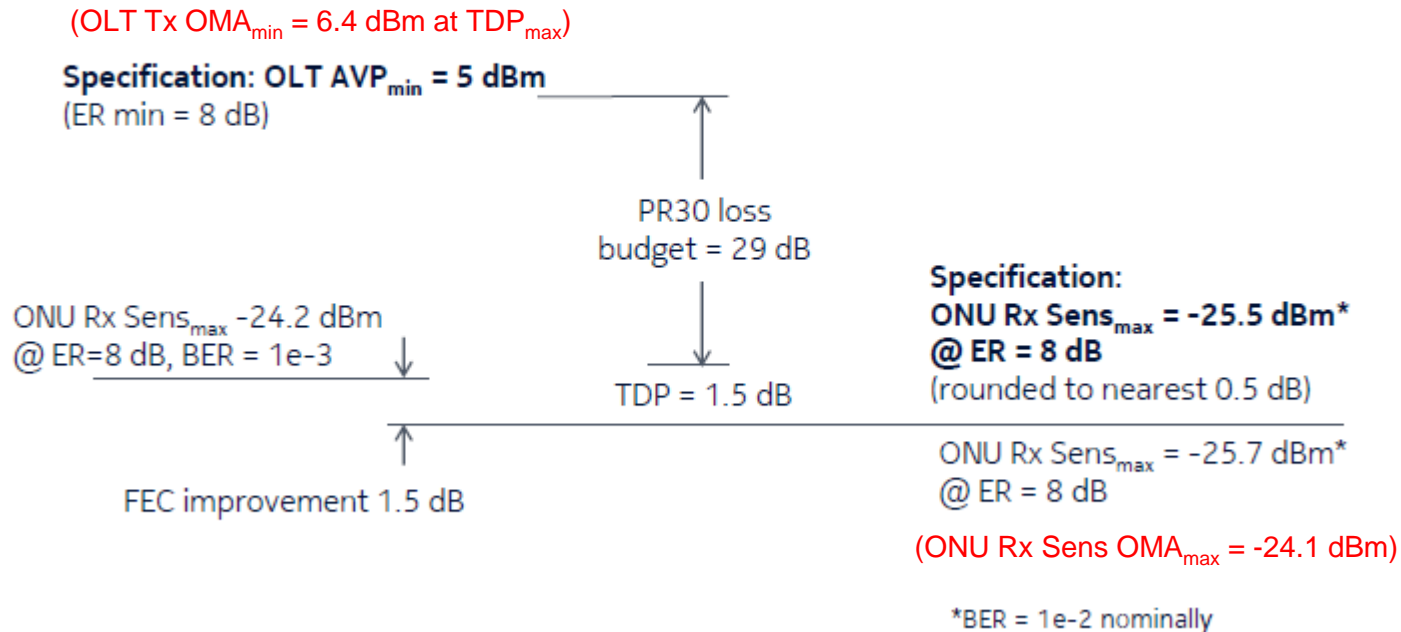
# 25G-EPON PMD Progress

- Consensus over the last several meeting cycles has provided sufficient definition to be able to generate a complete set of P802.3ca 25G-EPON PR30 PMD tables for downstream and upstream.
  - July 2017 Motion#5: US0 wavelengths
  - Jan. 2018 Motion#12: US0-A wavelength
  - Jan. 2018 Motion#15: US1 wavelength
  - March 2018 Motion#3: DS wavelengths
  - March 2018 Motion#7: US power budget
  - Jan. 2018 Motion#7: DS power budget
  - Jan. 2018 motion#8: Use Tx power minus penalties method of specification

# DS power budget

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25G EPON PR30 ONU receiver sensitivity and OLT launch power specs.



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## Transmitter launch power and receiver sensitivity values

The 25G EPON PR30 specifications proposed in [harstead\\_3ca\\_1b\\_0118](#)

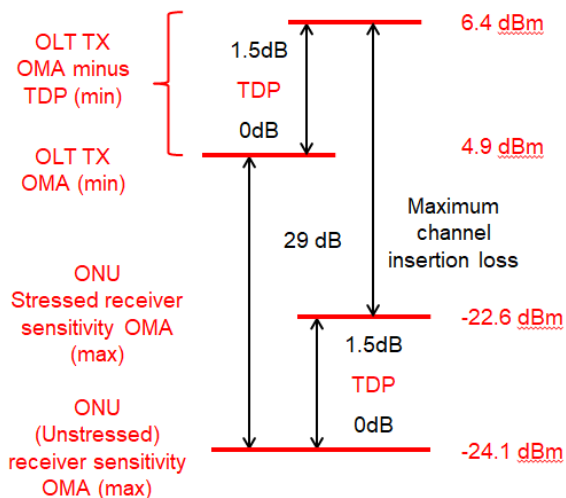
- 25G ONU receiver sensitivity: -25.7 dBm at BER= 1e-2 and ER=8 dB
- 25G OLT transmitter: AVPmin = 4.8 dBm and ER min = 8 dB

shall be adopted.

# DS Tx power minus penalties

## Power minus penalty method DS

Using 25G-EPON downstream power budget of Jan. 2018 Motion #7, converted to OMA.



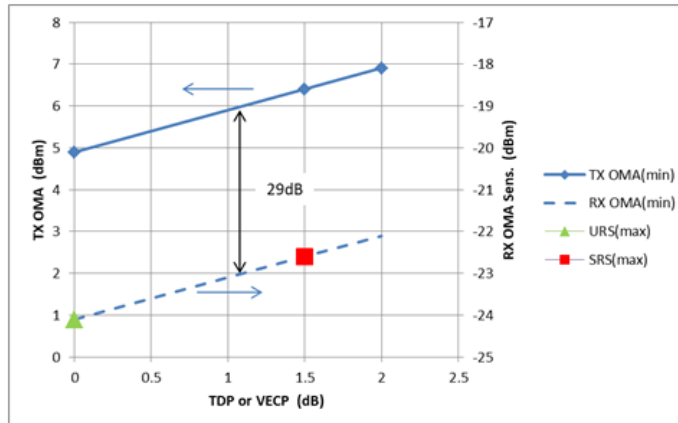
(OMA-TDP)(min) is **NORMATIVE** for all OLT TX. **Reference TDP=0dB is chosen based on TP of a best-case real EML TX.** Other values can be considered.

OMA(min) is **NORMATIVE** for all ONU TX. **Must be met even if TDP is < 0dB** to insure compliance even if TDP is negative.

SRS(max) is **NORMATIVE** for all ONU RX. Defined for a signal with specified vertical eye closure penalty (VECP) and jitter characteristics. Typically VECP = TDP(max).

URS(max) is **INFORMATIVE** for ONU RX. Defined for a TX with reference VECP = 0dB and max channel insertion loss.

## Power minus Penalty Method



- ONU TX OMA(min) depends on TDP
  - TX with TDP = 0dB only needs 4.9 dBm
  - Worst case TX (TDP=1.5dB) must launch 6.4 dBm
- Assumes real-world EML TX have TP ≥ 0dB
  - All OLT TX must launch OMA ≥ 4.9dBm
  - URS OMA(max) = -24.1dBm at VECP = 0dB
- Stressed ONU receiver sensitivity is defined for worst case TX with VECP = 1.5dB
  - SRS OMA(max) = -22.6dBm

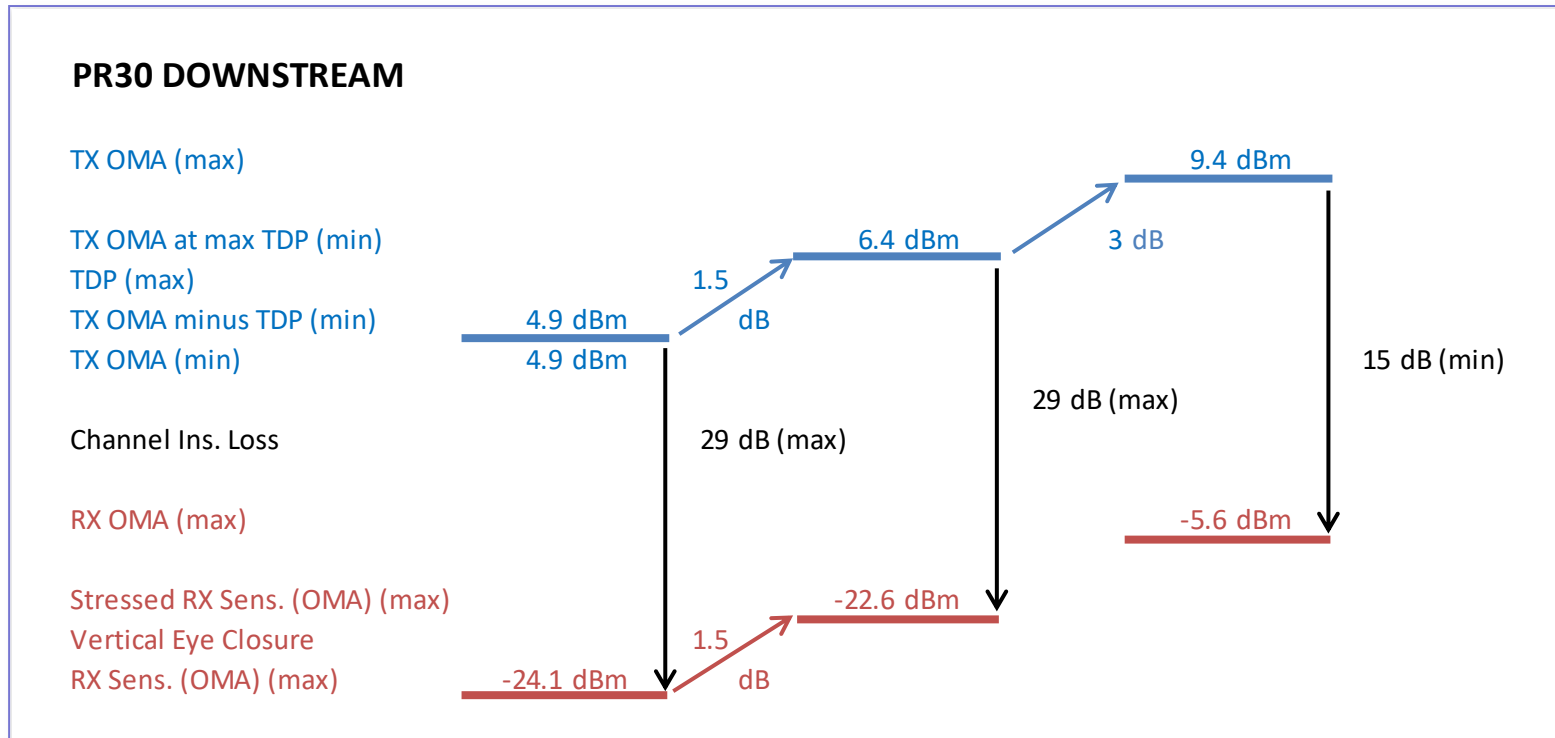
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Conversion of the DS power budget of Jan. 2018 Motion#7 was presented in johnson\_3ca\_1a\_0318.pdf.

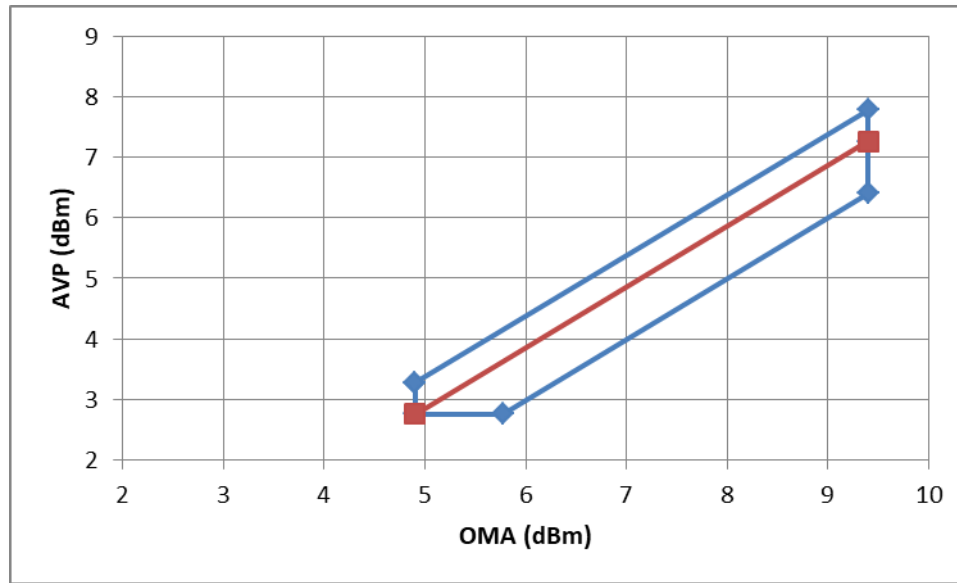
# PR30 DS power budget - expanded



Expanding on the analysis to include maximum values:

- Propose max OLT TX OMA is 3 dB higher than OMA at max TDP → 9.4 dBm. This is less than typically 5dB, but such high TX power is extremely unlikely.
- Assume the minimum channel insertion loss is 15 dB, same as 10G-EPON. This determines the maximum ONU RX OMA = -5.6 dBm.

# OLT TX AVP, OMA and ER



- The foregoing analysis uses OMA at the minimum extinction ratio  $ER = 8$  dB.
- Informative minimum Average Power (AVP) is proposed based on  $ER = 10$  dB at the value of minimum OMA, giving 2.8 dBm minimum.
- Informative maximum Average Power (AVP) is proposed based on  $ER = 8$  dB at the value of maximum OMA, giving 7.8 dBm maximum.
- All OLT TX must have both  $OMA > 4.9$  dBm and  $AVP > 2.8$  dBm, although only OMA is normative.

# OLT Transmit Characteristics

**Table 141-8 — OLT PMD Transmit Characteristics**

Description	25GBASE-PR30-D	Unit	Comment
Signaling speed (range)	25.78125 ± 100 ppm	GBd	P802.3ca Motion #5, Mar. 2017
Lane wavelengths (range)	1356 to 1360	nm	P802.3ca Motion #3, Mar. 2018
Side Mode Suppression Ratio (min)	30	dB	Common to all singlemode PMDs
Total average launch power (max)	—	dBm	Placeholder for 50G
Average launch power, each lane (max)	7.8	dBm	OMA(max) at ER = 8 dB
Average launch power, each lane <sup>a</sup> (min)	2.8	dBm	OMA(min) at ER = 10 dB
Optical Modulation Amplitude (OMA), each lane (max)	9.4	dBm	OMA(min)+TDP(max)+3dB
Optical Modulation Amplitude (OMA), each lane (min) <sup>b</sup>	4.9	dBm	P802.3ca Motion #7, Jan. 2018
Difference in launch power between any two lanes (OMA) (max)	—	dB	Placeholder for 50G
Launch power in OMA minus TDP, each lane (min)	4.9	dBm	harstead_3ca_1c_0118
Transmitter and dispersion penalty (TDP), each lane (max)	1.5	dB	harstead_3ca_1c_0118
Average launch power of OFF transmitter, each lane (max)	TBD	dBm	
Extinction ratio (min)	8	dB	harstead_3ca_1c_0118
RIN <sub>15</sub> OMA (max)	TBD	dB/Hz	
Optical return loss tolerance (max)	TBD	dB	
Transmitter reflectance <sup>c</sup> (max)	TBD	dB	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	TBD	UI	
Decision timing offset for transmitter and dispersion penalty	TBD	UI	

a Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

b Even if the TDP < 0 dB, the OMA (min) must exceed this value.

c Transmitter reflectance is defined looking into the transmitter.



# ONU Receive Characteristics

Table 141-14 — ONU PMD Receive Characteristics

Description	25GBASE-PR30-U	Unit	Comment
	Signaling speed (range)		
Lane wavelengths (range)	1356 to 1360	nm	P802.3ca Motion #3, Mar. 2018
Bit error ratio (max) <sup>a</sup>	10 <sup>-2</sup>	-	LDPC FEC
Damage threshold <sup>b</sup>	-6.2	dBm	APV(max) + 1 dB
Average receive power, each lane (max)	-7.2	dBm	OMA(max) at ER = 8 dB
Average receive power, each lane <sup>c</sup> (min)	-26.2	dBm	harstead_3ca_1c_0118
Receive power, each lane (OMA) (max)	-5.6	dBm	TX OMA(max) - 15 dB
Receiver reflectance (max)	TBD	dB	
Receiver sensitivity (OMA), each lane <sup>d</sup> (max)	-24.1	dBm	harstead_3ca_1c_0118
Signal detect threshold, each lane (min)	TBD	dBm	
Stressed receiver sensitivity (OMA), each lane <sup>e</sup> (max)	-22.6	dBm	harstead_3ca_1c_0118
Conditions of stressed receiver sensitivity test:			
Vertical eye closure penalty, <sup>f</sup> each lane	1.5	dB	harstead_3ca_1c_0118
Stressed eye J2 Jitter, <sup>f</sup> each lane	TBD	UI	
Stressed eye J9 Jitter, <sup>f</sup> each lane	TBD	UI	

a The BER of 10<sup>-12</sup> is achieved by the utilization of FEC as described in 142.2.2.5.

b The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level. Direct ONU–OLT connection may result in damage of the receiver.

c Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

d Receiver sensitivity (OMA), each lane (max) is informative.

e Measured with conformance test signal at TP3 (see 141.7.12) for BER = 10<sup>-2</sup>.

f Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

# US power budget

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## 25G upstream loss budget, PR30

ONU AVP<sub>min</sub> = ~~6.5~~ <sup>6.0</sup> dBm, ER=5 dB  
(ONU Tx OMA<sub>min</sub> = 6.2 dBm at TDP<sub>max</sub>)

loss budget 29 dB

OLT Rx Sens<sub>max</sub> -22.9 dBm  
@ ER=5 dB, BER = 1e-3

TDP = 2 dB

OLT Rx Sens<sub>max</sub> = ~~-24.4~~ <sup>-25.0</sup> dBm\* @ ER = 5 dB

25G US FEC improvement = 1.5 dB.

(OLT Rx Sens OMA<sub>max</sub> = -24.3 dBm)

Motion consensus values are based on liu\_3ca\_2\_0318.pdf

\*BER = 1e-2 nominally

Harstead\_3ca\_1c\_0318.pdf **NOKIA**

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### 25G PR30 upstream specifications

Adopt the following 25G EPON PR30 upstream specifications:

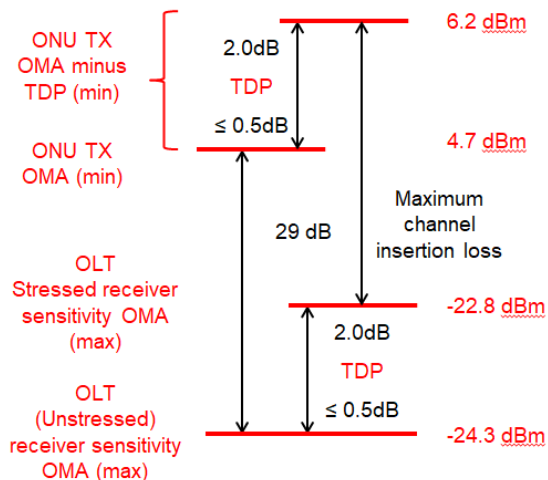
- 25G OLT receiver sensitivity: -25.0 dBm at BER = 1e-2 and ONU Tx ER = 5 dB,
- 25G ONU transmitter: ER<sub>min</sub> = 5 dB, (AVP minus TDP)<sub>min</sub> = 4.0dBm

and update the draft.

# US power minus penalties

## Power minus penalty method US

Using proposed 25G-EPON upstream power budget of harstead\_3ca\_2\_0318, converted to OMA.



(OMA-TDP)(min) is **NORMATIVE** for all ONU TX. **Reference TDP=0.5dB** is chosen based on TP of a best-case real DML TX. Other values can be considered.

OMA(min) is **NORMATIVE** for all ONU TX. **Must be met even if DP is < 0.5dB** to insure compliance even if DP over long fiber spans is negative.

SRS(max) is **NORMATIVE** for all OLT RX. Defined for a signal with specified vertical eye closure penalty (VECP) and jitter characteristics. Typically VECP = TDP(max).

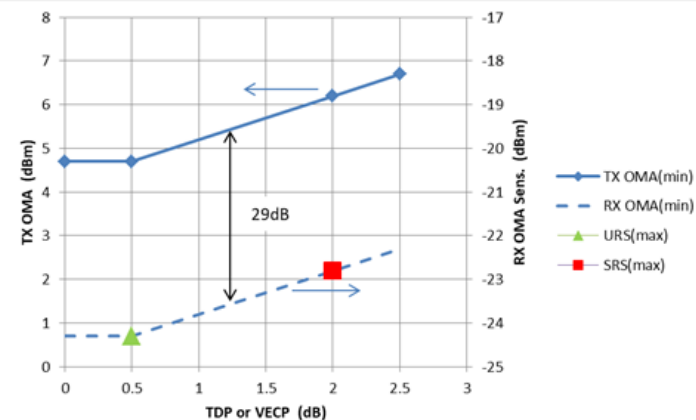
URS(max) is **INFORMATIVE** for OLT RX. Defined for a TX with reference VECP = 0.5dB and max channel insertion loss.

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## Power minus Penalty Method

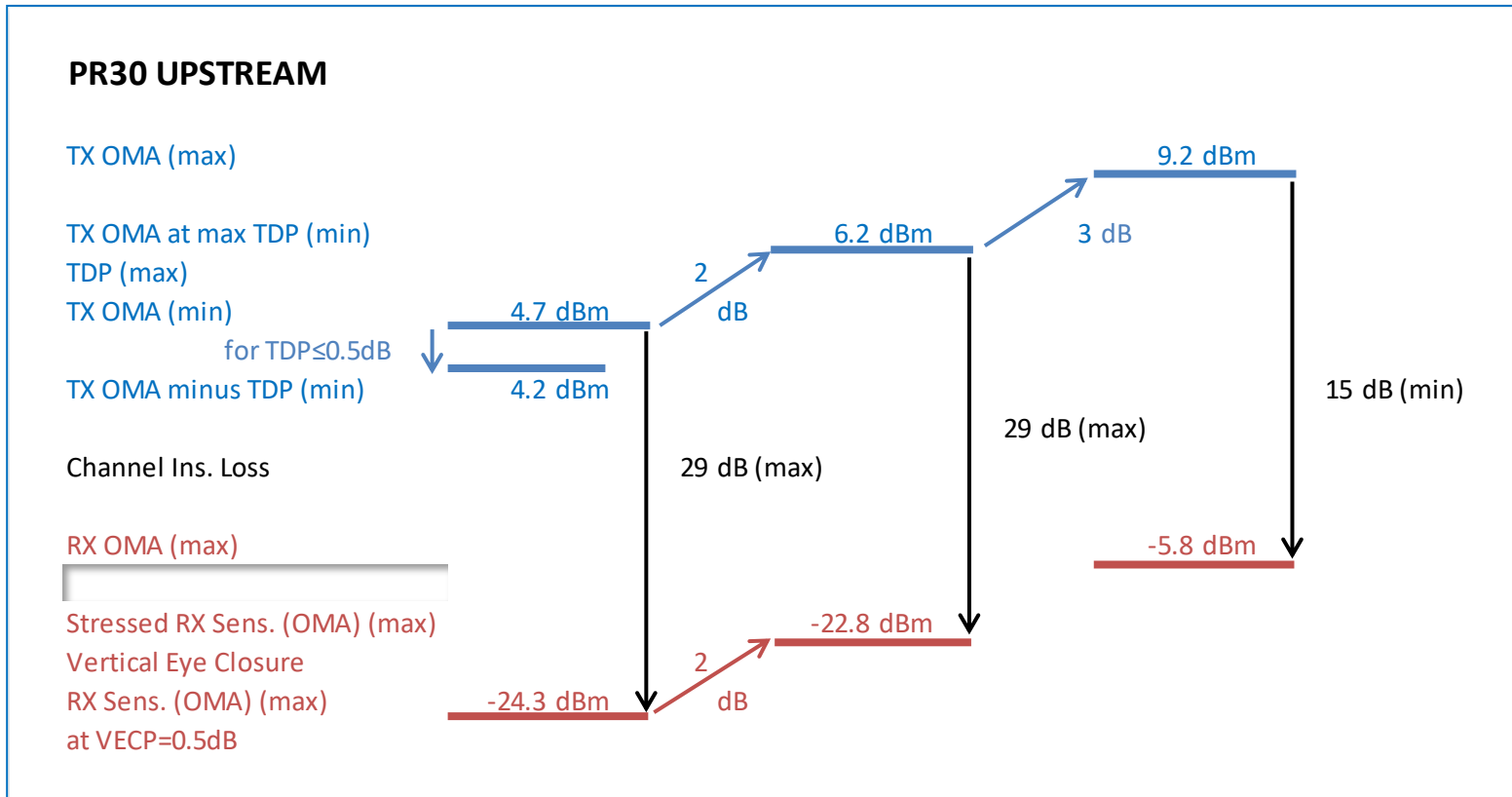


- ONU TX OMA(min) depends on TDP
  - TX with TDP  $\le 0.5\text{ dB}$  only needs 4.7 dBm
  - Worst case TX (TDP = 2dB) must launch 6.7 dBm
- Assumes real-world DML TX have TP  $\ge 0.5\text{ dB}$ 
  - All ONU TX must launch OMA  $\ge 4.7\text{ dBm}$
  - URS OMA(max) = -24.3dBm at VECP = 0.5dB
- Stressed ONU receiver sensitivity is defined for worst case TX with VECP = 2dB
  - SRS OMA(max) = -22.8dBm

Conversion of the US power budget of harstead\_3ca\_2\_0318 was presented in johnson\_3ca\_1a\_0318.pdf.

The numerical values shown here have been modified to be in agreement with the final values in March 2018 Motion#7.

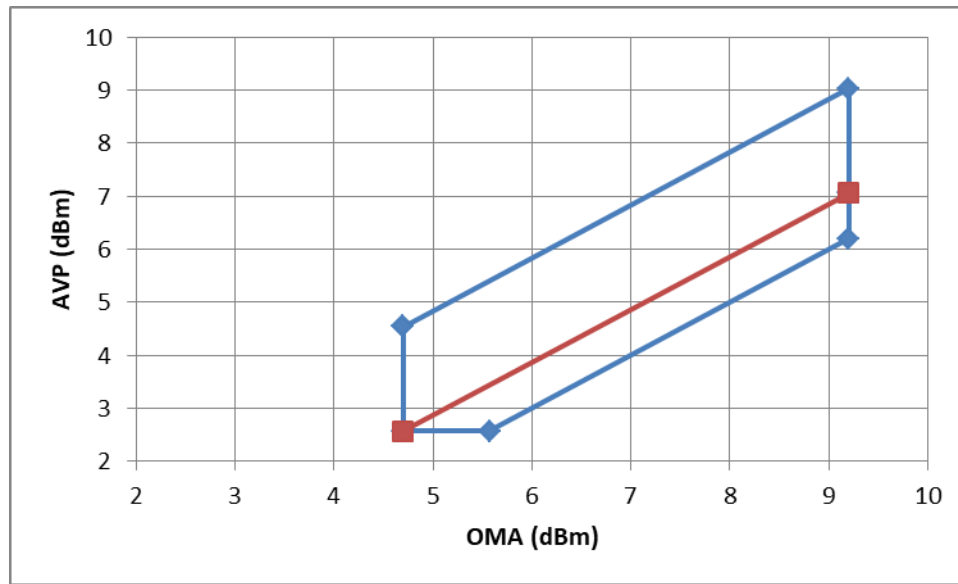
# PR30 US power budget - expanded



Expanding on the analysis to include maximum values:

- Propose max ONU TX OMA is 3 dB higher than OMA at max TDP → 9.2 dBm. This is less than typical 5dB, but such high TX power is extremely unlikely.
- Assume the minimum channel insertion loss is 15 dB, same as 10G-EPON. This determines the maximum OLT RX OMA = -5.8 dBm.

# ONU TX AVP, OMA and ER



- The foregoing analysis uses OMA at the minimum extinction ratio  $ER = 5$  dB.
- Informative minimum Average Power (AVP) is proposed based on  $ER = 10$  dB at the value of minimum OMA, giving 2.6 dBm minimum.
- Informative maximum Average Power (AVP) is proposed based on  $ER = 5$  dB at the value of maximum OMA, giving 7.1 dBm maximum.
- All ONU TX must have both  $OMA > 4.7$  dBm and  $AVP > 2.6$  dBm, although only OMA is normative.

# ONU Transmit Characteristics

Table 141-12 — ONU PMD Transmit Characteristics

Description	25GBASE-PR30-U 50/25GBASE-PR30-U	Unit	Comment
Signaling speed (range)	25.78125 ± 100 ppm	GBd	P802.3ca Motion #5, Mar. 2017
Lane wavelengths (range)	1260 to 1280 1290 to 1310	nm	P802.3ca Motion #5, Mar. 2017 P802.3ca Motion #12, Jan. 2018
Side Mode Suppression Ratio (min)	30	dB	Common to all singlemode PMDs
Total average launch power (max)	—	dBm	Placeholder for 50G
Average launch power, each lane (max)	9	dBm	OMA(max) at ER = 5 dB
Average launch power, each lane <sup>a</sup> (min)	2.6	dBm	OMA(min) at ER = 10 dB
Optical Modulation Amplitude (OMA), each lane (max)	9.2	dBm	OMA(min)+TDP(max)+3dB
Optical Modulation Amplitude (OMA), each lane (min) <sup>b</sup>	4.7	dBm	P802.3ca Motion #7, Mar. 2018
Difference in launch power between any two lanes (OMA) (max)	—	dB	Placeholder for 50G
Launch power in OMA minus TDP, each lane (min)	4.2	dBm	P802.3ca Motion #7, Mar. 2018
Transmitter and dispersion penalty (TDP), each lane (max)	2	dB	P802.3ca Motion #7, Mar. 2018
Average launch power of OFF transmitter, each lane (max)	TBD	dBm	
Extinction ratio (min)	5	dB	P802.3ca Motion #7, Mar. 2018
RIN <sub>15</sub> OMA (max)	TBD	dB/Hz	
Optical return loss tolerance (max)	TBD	dB	
Transmitter reflectance <sup>c</sup> (max)	TBD	dB	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	TBD	UI	
Turn-on time (max)	TBD	ns	
Turn off time (max)	TBD	ns	
Decision timing offset for transmitter and dispersion penalty	TBD	UI	

a Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

b Even if the TDP < 0.5 dB, the OMA (min) must exceed this value.

c Transmitter reflectance is defined looking into the transmitter.

# OLT Receive Characteristics

**Table 141-10 — OLT PMD Receive Characteristics**

Description	25GBASE-PR30-D	Unit	Comment
Signaling speed (range)	25.78125 ± 100 ppm	GBd	P802.3ca Motion #5, Mar. 2017
Lane wavelengths (range)	1260 to 1280 1290 to 1310	nm	P802.3ca Motion #5, Mar. 2017 P802.3ca Motion #12, Jan. 2018
Bit error ratio (max) <sup>a</sup>	10 <sup>-2</sup>	-	LDPC FEC
Damage threshold <sup>b</sup>	-5	dBm	AVP(max) + 1 dB
Average receive power, each lane (max)	-6	dBm	OMA(max) at ER = 8 dB
Average receive power, each lane <sup>c</sup> (min)	-26.4	dBm	P802.3ca Motion #7, Mar. 2018
Receive power, each lane (OMA) (max)	-5.8	dBm	TX OMA(max) - 15 dB
Receiver reflectance (max)	TBD	dB	
Receiver sensitivity (OMA), each lane <sup>d</sup> (max)	-24.3	dBm	P802.3ca Motion #7, Mar. 2018
Signal detect threshold, each lane (min)	TBD	dBm	
Stressed receiver sensitivity (OMA), each lane <sup>e</sup> (max)	-22.8	dBm	P802.3ca Motion #7, Mar. 2018
Receiver settling time (max)	TBD	ns	
Conditions of stressed receiver sensitivity test:			
Vertical eye closure penalty, <sup>f</sup> each lane	2	dB	P802.3ca Motion #7, Mar. 2018
Stressed eye J2 Jitter, <sup>f</sup> each lane	TBD	UI	
Stressed eye J9 Jitter, <sup>f</sup> each lane	TBD	UI	

a The BER of 10<sup>-12</sup> is achieved by the utilization of FEC as described in 142.2.2.5.

b The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level. Direct ONU–OLT connection may result in damage of the receiver.

c Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

d Receiver sensitivity (OMA), each lane (max) is measured with a signal with VECF = 0.5 dB and is informative.

e Measured with conformance test signal at TP3 (see 141.7.12) for BER = 10<sup>-2</sup>.

f Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

# Summary

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- ❑ Consensus over the last several meeting cycles has provided sufficient definition to be able to generate a nearly complete set of P802.3ca 25G-EPON PR30 PMD tables for downstream and upstream.
  - The author and supporters will work towards generating consensus on the remaining TBD values between now and the May 2018 meeting.
- ❑ A motion will be brought at the May 2018 meeting to accept the format and contents of the PMD tables and associated footnotes in this contribution into the next revision of the P802.3ca Task Force draft.